

Decision Support System of Coal Mine Planning Using System Dynamics Model: Introduction and Reviews

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Abstract: *This research proposes to apply the dynamics system theory for developing the decision support system tool of the coal mine planning system by taking into account complex variables of the coal mining and processing, transportation, economic and environmental impacts. Successful development of this tool will help the policy maker to provide better planning and effective management policy in coal mining systems.*

Keywords: Decision Support System; System Dynamics; Coal; Mine Planning System

1. Introduction

Coal is one of the World's most plentiful energy resources. It is today and will be in the future the most important global source of electricity [1]. Nowadays, there are many coal reserves and the large coal mining are under operation in several countries.

Although the current coal mining process has been well managed in some country by the advanced technologies, high environmental impact remains occur in the large area of community nearby the coal mine. In this research, dynamic systems theory will be used for solving several complex systems by converting multiple variables into System Dynamics Model (SDM). It is noted that this theory was firstly presented by Professor Jay W. Forrester from MIT [2]. After that Meadow et al., published the well-known books that referred to this theory are "Limit to Growth" and "Beyond the Limit" [3]. Until now, the system dynamics theory is used in many fields of research.

Therefore, an idea of applying the decision support system as a fast and flexible tool to help managing the whole coal mining process will be proposed. The simulation will cover not only the coal mining area but also the wider area for protecting environment on this model results, the clear scenarios with well understandable on both positive and negative impacts of coal mine system can be identified, which helps the coal mining industries to make the right decision on their policies economic and management plans during complex variables.

2. Objective

To design and develop a decision support system tool for coal mine planning system by using system dynamics model.

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3. Literature Reviews

Fan et al. (2007) developed a system dynamics base model for coal investment in china. In this paper, a system dynamics model was developed taking the investment in the coal industry, available reserves, mine construction and coal supply capability into account [4].

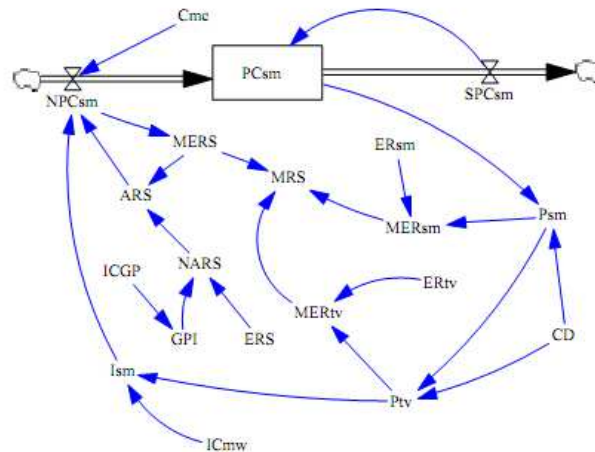


Figure 1: Fan's Flow diagram of coal production and supply [4]

The results of Fan's research showed many scenarios. The simulation of the model helps to find the satisfied and economical scenario, such as the available reserves would approximately get to 8.6 billion tons every year, which can meet the requirements of China's economic goal on coal in 2020 [4].

Caselles-Moncho, et al. (2006) studied about Dynamic simulation model of a coal thermo-electric plant with a flue gas desulphurization system. This research developed a Dynamic Simulation Model that had been used to present the likely responses of the electricity industries' latest perturbations such as: changes in environmental regulations, international fuel market evolution, restriction on fuel supply and increase on fuel prices, liberalization of the European Electricity Market, and the results of applying energy policies and official tools such as taxes and emission allowances [5].

The model was intended to study the economic viability of the Power Plant, three simulation scenarios (sets of uncontrollable input variables) were proposed for discussion. The definition of scenarios was based on the evolution of the government Energy Strategy during the last century: policies promoting investments in the different generating technologies, policies promoting environmental impact minimization, consumption of national raw energy material, and the criteria applied to electric rates [5].

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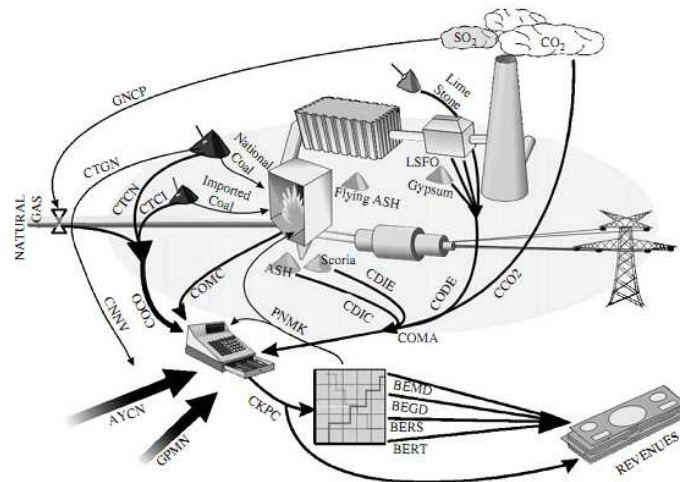


Figure 2: Concept of the Caselles-Moncho's model [5]

The results of Caselles-Moncho's research show the optimal strategy including: (a) minimum energy production (b) specific net consumption of 2,207,000Th/GWh (the consumption curve means), (c) theoretical participation of the different fuels, (d) desulphurization running at 100% and (e) minimum commercialization of ashes, scoria and gypsum [5].

Bian, et al. (2010) studied about Environmental issues from coal mining and their solutions. This research shows that the environmental challenges of coal mining include coal mine accidents, land subsidence, damage to the water environment, mining waste disposal and air pollution. These are either environmental pollution or landscape change. A conceptual framework for solving mine environmental issues was proposed. Clean processes, or remediation measures, were designed to address environmental pollution [1].

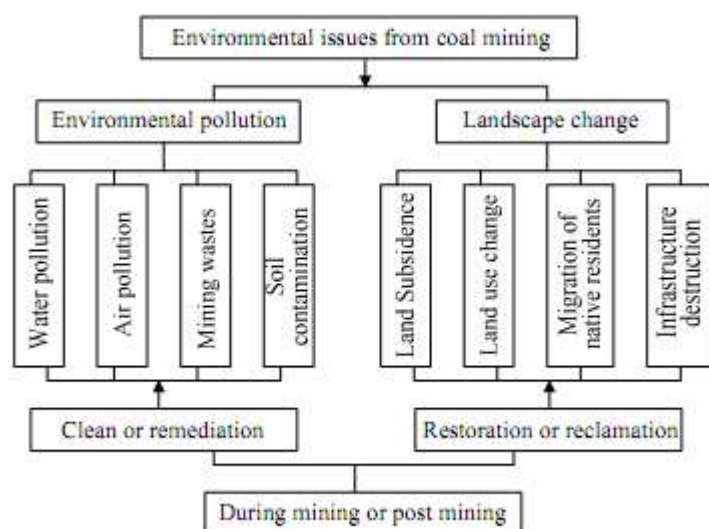


Figure 3: Bian's conceptual framework for solving the environmental issues [1]

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O'Regan et al. (2001) from Ireland, published paper about an insight into the system dynamics method: a case study in the dynamics of international minerals investment. This paper presents an explanation of the system dynamics method. The aim of the model discussed in this paper was to examine how environmental policy affects the investment and development decisions of the mining industry within the broader context of government minerals policy [6].

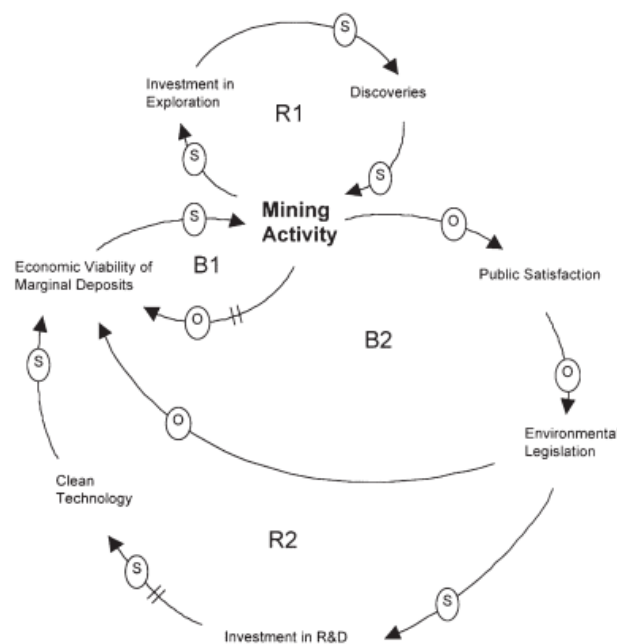


Figure 4: Principle of the O'Regan model diagram [6]

In summary, the O'Regan's model aims to encapsulate best practice in the field of system dynamics. It emphasized the difference between actual and perceived conditions as a basis for action. It made explicit the underlying assumptions as a basis for further expansion. It highlighted system structure as a catalyst for change. It did not by itself provide objective answers. Instead, it was a learning device, an aid to understanding. It was not a replacement for analytical thinking, but rather complementary to it [6].

4. Research Methodology

4.1 Boundary of Research

This research will be developed dynamics model of the coal mine planning system to be a decision supported system tool by using Vensim DSS Software [7]. The model is focused on surface coal mining and including cost of environmental protections.

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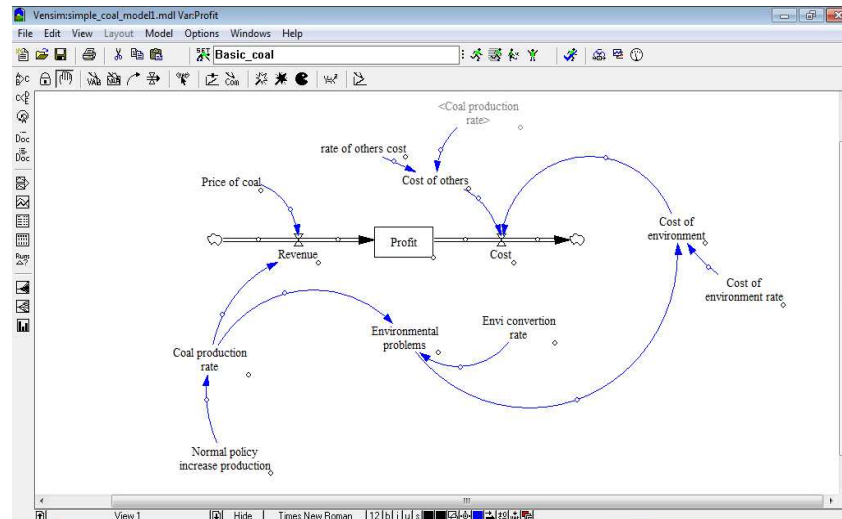


Figure 5: Vensim software and example SDM

4.2 Methodology

The dynamics system theory and software will be used. The decision of this tool will be based on economic decision by using Net Present Value (NPV), Internal Rate of Return (IRR) [8-10] and Break Even Point (B.E.P.) [10-11] for coal feasibility study and coal mine operating included cost of environment protection.

4.3 Frame work diagram

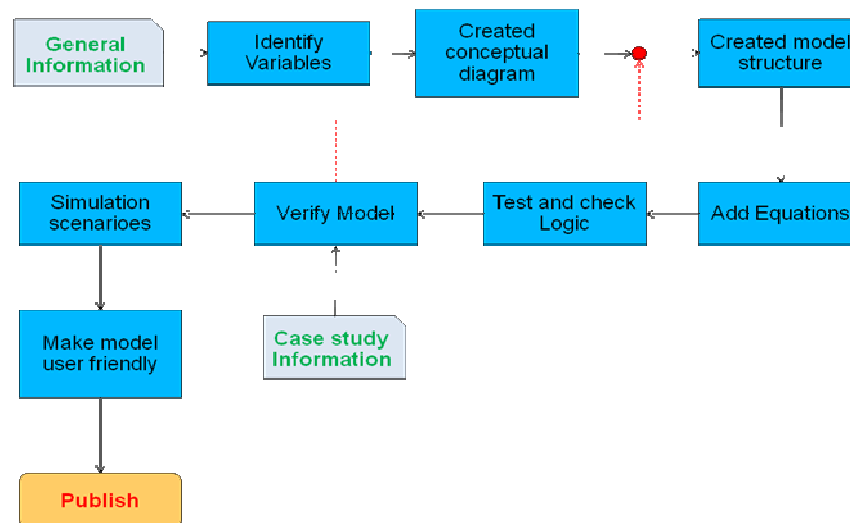


Figure 6: Processing diagram of this research

4.4 Case Study

The case study of this research will focus on surface coal mining in Germany and/or in Thailand.

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5. Summary

This research aims to develop the decision support system tool for solving complex variables problems. Furthermore, the model will be help to understand the relationship of all relevant variables in the coal mining system. The tool will be developed by using dynamics system theory and will be performed and displayed under various simulated scenarios for optimizing the most suitable operating conditions rapidly. Successful development of this tool will lead to the proper planning and suitable management policy in the coal mining system.

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